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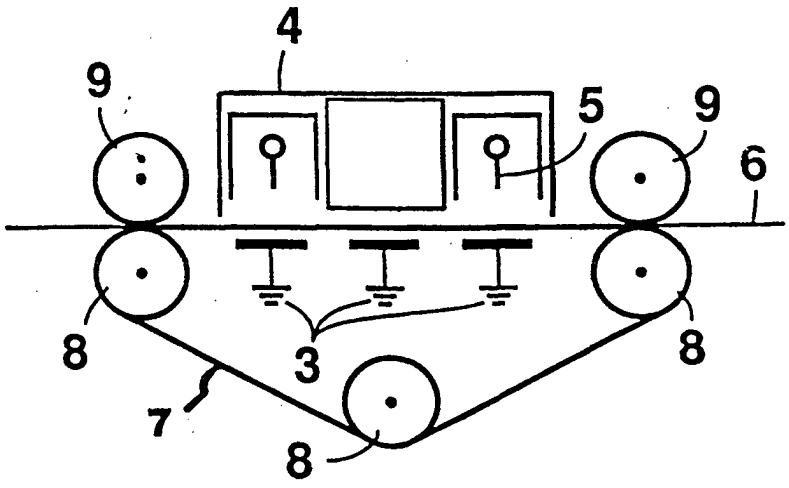
(54) Title: METHOD AND ASSEMBLY FOR GUIDING A WEB OF PAPER OR BOARD WEB DURING MANUFACTURE

(57) Abstract

Method and assembly for guiding a web of paper or board or, alternatively, an edge strip sheared therefrom, in a paper machine or finishing equipment, the method being particularly suited for threading the web tail or edge strip through the machine in conjunction with a production shutdown or after a web break. According to the invention, the web (6) or its tail sheared from the web so as to form an edge strip is supported electrically by means of taking surfaces or electrodes (3, 5) disposed on opposite sides of the web (6) to different potentials. Particularly advantageously, the web (6) or the edge strip can be adhered to a roll (16), a belt (7) or a wire by taking said support element to a lower potential and disposing a higher–potential electrode (5) or a number of electrodes to the opposite side of the web.



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Method and assembly for guiding a web of paper or board web during manufacture

The present invention concerns a method according to the preamble of claim 1 for guiding a web of paper or board or, alternatively, a strip sheared therefrom, in a paper machine or finishing equipment, the method being particularly suited for threading the web tail or edge strip through the machine after a production shutdown or after a web break.

The invention also concerns an assembly suitable for implementing said method.

After a web break or production shutdown on a papermaking line, the web being processed must be threaded through the machine in conjunction with the next startup. Guidance of the web tail during threading is clumsy and, moreover, is further complicated by the huge width of modern paper machines and the practical constraint that the machine must be accelerated to a relatively high speed before the web tail can be passed through the machine. Consequently, manual guidance of the web is normally impossible, but rather, an automated technique of web tail threading must be used. In off-machine coating lines, manual threading is also feasible, because herein the base paper web is paid off directly from a ready-wound roll to the coating line. The line need not be started prior to web tail threading, but instead the web tail can be threaded so that the web end is first sheared into a tapering tail having its tip made in the center or edge of the web tail, to which tip is adhered by glueing a rope or belt that is threaded first manually for a certain length into the coating line, and finally the web is pulled with the help of the rope/belt through the entire machine. This kind of web tail threading and adherence of the rope to the web tail is clumsy operation causing notable reduction in productivity due to web breaks.

An alternative method of threading the web through the machine is to use tail threading ropes. The threading rope system comprises a plurality of paired loops of ropes placed on one side of the machine, whereby the nips formed between the rope loops can accomplish tail threading by transporting a narrow leader strip cut to the web tail. In this method, web tail threading takes place by trimming the edge of the leading web tail at the breakage point into a narrow leader strip that is carried downstream along the side of the machine in the nip formed between the opposed ropes. Each pair of the rope loops extends over a given length of the machine and the edge strip is delivered at the downstream end of each rope loop to the next rope loop. When the edge strip is being transported downstream, the rest of the web is directed to the pulper, whereby a substantial amount of broke results. After the edge strip has been delivered by one loop to be transported by the next pair of opposed ropes, the web can be allowed to assume its full width. This takes place by moving the edge-strip-shearing knife in a cross-machine direction over the running web, whereby the web is widened from the narrow edge strip to its full width and, simultaneously, the web widening with the progress of the cutting operation up to its full width is guided in the machine to the next rope nip, where the excess width of the web is directed into the pulper. Subsequently in this manner, the edge strip is passed into the next rope nip, transported therein over the entire length of the rope loop and then again widened to its full width. Naturally, the edge strip can be passed through a number of rope loops prior to moving the cutting knife to widen the web to its full width, but herein the risk of breaking the thin edge strip increases. As such, the break of the edge strip is not catastrophic, but should a break occur, the threading of the edge strip must be

restarted downstream along the web travel from a point upstream to the breakage point and, thereby, the time spent for web tail threading is extended.

Instead of using a threading arrangement based on a rope nip, the web can be threaded using a belt threading system in which the edge strip is adhered to the threading belt using glue or self-adhesive tape and then proceeding the threading in the above-described manner.

In modern paper coating equipment, supported web threading is preferred. Herein, it is important to keep the web steady on the support belt or wire. Conventionally, the web is adhered by means of suction rolls or other vacuum devices or, alternatively, using air-blasting during drying for instance, and generally the wet web adheres relatively tenaciously to the belt-like support means. Yet, supported web guidance at the delivery of the web from one support element to another remains problematic and moreover so in the application of a coating wherein the web must always be supported from its dry side requiring that the supported side of the web is changed at each new support element. The web support at the crossover point can be provided by means of a short support belt or using an air-jet supported web travel. Conventionally, air-jet supported web travel is used in a dryer section, whereby the air flow serves for both the drying energy transfer to the web and the support of the web travel.

In the art, there are still problems in the support and guidance of the web tail travelling from one roll to the next and, in a winder, onto the mandrel in conjunction with a roll change.

It is an object of the present invention to provide a method suited for on-line guidance and support of a running

web of paper or board or, alternatively, a threading tail thereof during its travel through a papermaking machine and finishing equipment related thereto.

The goal of the invention is achieved by virtue of supporting the web or, respectively, a threading tail of the web, by electrical means comprising surfaces or electrodes adapted to the opposite sides of the web and brought to different electrical potentials. Particularly advantageously, the web or the leader strip of the web can be adhered to a support roll, belt or wire by bringing said support element to a low potential and placing on the opposite side of the travelling web an electrode or number of electrodes brought to a higher potential.

More specifically, the method according to the invention is characterized by what is stated in the characterizing part of claim 1.

Furthermore, the assembly according to the invention is characterized by what is stated in the characterizing part of claim 9.

The invention provides significant benefits.

By virtue of the invention, the edge strip of the web can be passed during tail threading in a reliable manner over the unsupported crossover points of the supported path from one support element to the next support element, e.g., into the next rope nip. When so required, the rope nips can be replaced by belts, whereby the arrangement according to the invention provides electrical adherence of the edge strip to the belt thus enabling only one belt to be used for carrying the edge strip forward. If the web is arranged to travel supported over almost its entire length, a separate

threading rope or belt system is not necessarily needed, because the edge strip may be adhered to the support element and, by electrical means, passed over the discontinuities of the web path. In fact, the web may be even guidedly passed at web path crossover points, e.g., from a belt onto a roll and vice versa by virtue of making it supportedly float under the guidance of electric forces. In fast machines the invention can be applied for eliminating web bagginess, which is caused by air entrainment at backing rolls supporting a fast running web, by means of bringing the backing roll to a low potential and then placing electrodes of higher potential to the opposite side of the web. This arrangement causes the web to adhere firmly to the backing roll, whereby air cannot readily become entrained between the web and the roll. With the help of the electric field, the web can also be released from the roll and transported to the next roll or belt/wire in the same fashion as has to date been done using an air jet and a releasing doctor blade. Web threading implemented using rope carriers has a problem in that carrier ropes cannot be passed via coaters and web measurement beam devices, but instead, the ropes must make a bypass at these units. Now the novel invention makes it possible to pass the edge strip of the web electrically supportedly in the gaps of these units, thus permitting the carrier ropes or belts to have a discontinuity at these points. By virtue of the invention, two-sided measurement of the web can be accomplished also along a supported web travel inasmuch the web support at the gauging equipment can be implemented using electrical means instead of a wire or belt.

In the following, the invention is described in more detail with reference to appended drawings in which

Fig. 1 shows diagrammatically a web guidance system

according to the invention adapted at the crossover point between two rolls;

Fig. 2 shows diagrammatically a direct web guidance arrangement between two rolls;

Fig. 3 shows an edge strip guidance arrangement according to the invention between two rope loops;

Fig. 4 shows a guidance arrangement according to the invention for engaging the web tail around a winder mandrel; and

Fig. 5 shows a draw roll group in which the web is adhered to the rolls by electrical means.

Using an arrangement according to the invention, electric forces can be used for adhering a web or an edge strip thereof to a moving carrier such as a wire, belt, band or for guiding around a roll. Herein, it is often sufficient to pass the web past the gap of two electrodes over which a potential difference is applied. Then, a web passing through the electrode gap is transferred under electric forces to the electrode of the lower potential and is adhered thereto. Web guidance may, however, be implemented more advantageously using the so-called ion-blast technique particularly in cases where the web is desired to be guided by means of the method according to the invention along a curved path.

The ion-blast technique, or "ionipuhallustekniikka", is based on forming a strong electric field between one or typically a plurality of pointed electrodes and one planar counterelectrode. The tip of the pointed electrode emits a corona discharge that charges particles located in the

vicinity of the electrode tip thus causing the generation of ions in the electronegative gaseous medium. The ions migrate along the field lines extending between the electrode and the counterelectrode which is taken to the ground potential or even to a lower potential, whereby the ions adhere to particles they meet on their travel. The electric field transports the charged particles over the interelectrode gap toward the ground-potential electrode, where they attach to the substrate by electric and mechanical forces. If the distance between the opposed electrodes is large and the applied voltage is high (more than 50 kV), a gas flow is established between the opposed electrodes that mechanically transports the charged particles within the interelectrode gap toward the ground potential. This flow is conventionally known as ion blast. In the ion-blast phenomenon, the electric field exiting from the tip of the pointed electrode forms a conical field pattern in which the ionized gas and charged particles move.

The effective coverage of the conical flux tubes emitted by the electrode tips must extend over the desired area on the web. As the electric field lines leaving the tip of each pointed electrode form a flux tube of a conical shape, the number and location of electrode tips must be configured so that the conical flux tubes leaving the staggered electrode tips provide a field pattern of uniform coverage on the counterelectrode. The voltage applied to the electrodes is dependent on the distance between the counterelectrode and the electrode tips that may be varied from 2 mm to 2 m; however, to keep the space requirements of the different devices comprised in the equipment within practicable limits, an interelectrode distance range of 100 - 1000 mm is favoured. While a large interelectrode distance as such does not impair the function of the apparatus, it increases the external dimensions of the system. When using a design

based on the practicably most favourable interelectrode distance range, the voltage applied between the opposed electrodes is typically set to be in the range 80 - 160 kV, but may be varied as widely as from 30 kV to 1000 kV. The counterelectrode may be run positive or negative, and the electrode tips may respectively be connected to the negative or positive terminal of the power supply.

In Fig. 1 is shown the control of web travel by means of ion-blast devices along a curved path downstream from a first roll 1 to a second roll 2. This arrangement is suited for, e.g., guiding the web from a coating station backing roll 1 in a noncontacting manner along a curved path to a first lead-in roll 2 of the dryer section. In the embodiment illustrated in Fig. 1, the counterelectrodes 3 that form the lower-potential electrodes 3, advantageously connected to the ground potential, are disposed on the outer perimeter side of the curved web path, while the pointed electrodes 5 placed in enclosures 4 are disposed on the inner perimeter side of the curved web path. Then, the ion blast emitted by the pointed electrodes 5 moves the web 6 by electric forces and the mechanical effects of the ion-blast gas flow toward the ground electrodes 3, whereby the web 6 is tensioned on a curved path determined by the arrangement of the electrodes 3, 5. In the same fashion the web may also be transported along a straight path if the electrodes of the higher and lower potential are disposed in an alternating manner to opposite sides of the web. While not explicitly mentioned, the electrodes are in a conventional manner fed by a high-voltage power supply 18, as is also the case in the alternative embodiments described later in the text. The polarity of the electrodes is made changeable, e.g., by providing the power supply with appropriate switch-over means. Then, the polarity change can be implemented by manual means or, alternative-

ly, utilized for automated control of web travel.

In Fig. 2 is shown the adherence of the web to a support belt 7. The support belt is arranged to travel about a set of guide rolls 8 disposed in a triangular configuration in which two of the guide rolls 8 are placed in a close proximity of web guide rolls 9 so that the web 6 travels supported by said belt between said latter rolls. Over the travel of the web 6 supported by the belt 7, there are disposed three counterelectrodes 3 and three separate groups of ion-blast electrodes are located thereabove on the opposite side of the web. The web support belt is advantageously made from a conducting material. In the illustrated embodiment, the web 6 is adhered by electric forces to the belt 7 and, supported by the said belt, travels the distance between the guide rolls 9 supporting the web 6. Alternatively, the same assembly may be used for guiding and supporting an edge strip or a full-width web between two support elements such as a belt or wire or for supporting an edge strip over the distance between two rope nips. The assembly is advantageously made movable, thus allowing the assembly to be introduced to the crossover point of the support system at the start of tail threading and then to be retracted after a successful web threading operation.

In Fig. 3 is shown an arrangement according to the invention for guiding the edge strip at the crossover point between two support belts. Also an arrangement may be contemplated capable of guiding a full-width web at the crossover point of two support belts or wires. As shown in the diagram, the edge strip 10 leaves a first guide belt 11 to be next passed via the gap formed between electrodes 5 and 3 of a deflection roll onto another guide belt 13 arranged to pass over rolls 14, 15. From the first belt 10, the edge strip is guided by means of the electrodes 3, 5 to

a roll 14 from which the edge strip 10 is deflected by means of a second set of electrodes 5 toward the guide belt 13 passing over the guide roll 14. In the illustrated embodiment, the edge strip 10 is transported by being adhered to the guide belts 11 and 13 with the help of electrical field techniques. The first guide belt 11 passes over at least one guide roll 12 taken to a lower potential, thereby also taking the guide belt 11 to said lower potential. To the side of the guide belt 11 facing the edge strip 10, there is disposed a higher-potential electrode 5 that in cooperation with the conducting guide belt 11 forms an electric field capable of adhering the edge strip to the guide belt 11. The edge strip 10 is adhered in a similar manner with the help of the field emitted by the guide electrodes 5 to the next guide belt which is taken to the ground potential via guide rolls 14, 15. Over the web travel portion remaining between the belts 11, 13, the edge strip 10 is transported with the help of the electric field formed between the fixed electrodes 3, 5. These electrodes are arranged so that to opposite sides of the travelling edge strip are disposed electrodes taken in an alternating order to a lower and a higher potential, thus causing the direction of the electric field to change cyclically so that the edge strip stays centered between the electrodes. In this fashion, the edge strip can be passed through the entire machine adheringly supported by the guide belts.

In Fig. 4 is shown one technique of guiding the web tail around a winder mandrel 17. In the illustrated embodiment, the mandrel 16 is brought to the lower potential, advantageously to the ground potential, and the electrodes taken to the higher potential are arranged in groups surrounding the mandrel 16. Since this arrangement functions very satisfactorily based on the electrostatic field alone, the shape of the electrodes can be varied freely. As ion-blast

forces, however, offer a more effective technique of moving the tail of the web 6 toward the mandrel 16, the use of pointed electrodes combined with a high potential difference is more advantageous. Obviously, while the assembly of Fig. 4 can be used for guiding a web tail to rolls or cylinders, it requires additional means such as a mechanical scraper for preventing the winding-up of the web tail about the roll/cylinder and for urging the tail to travel forward in the machine.

In Fig. 5 is shown an assembly capable of improving the adherence traction imposed by the drawing cylinder group on the web. At high web speeds, the air travelling as a boundary layer on the web surface becomes entrained into the converging nip between the rolls 17 and the web 10, whereby the traction of the nip on the web is lost. Then, the draw that tensions the web cannot be maintained and the transport of the web through the machine becomes complicated. The traction can be improved by taking the draw rolls 17 to a low potential, advantageously to the ground potential, and simultaneously arranging to a close proximity thereof a set of higher-potential electrodes 5, whereby the electric field established between the rolls and the electrodes adheres the web to the draw rolls without any loss of traction. The electric field also increases the mechanical friction by preventing the entry of air into the nip between the rolls and the web. Besides in draw roll groups, the arrangement of Fig. 5 may also be used in conjunction with other rolls such as dryer cylinders not equipped with a support wire.

In addition to those described above, the invention may have alternative embodiments.

In coater stations, for instance, the invention may be

utilized for preventing bagginess of the web. Bagginess results from the entrapment of air travelling along with the web into the converging nip between a roll and the web passing over the same, thus separating the web from the roll, whereby a bag is formed in the web in front of a coating applicator or the doctor units when the web is pressed against the backing roll. Bagginess can be avoided by taking the backing roll to the ground potential or a low potential and disposing at the tangential meeting point of the web with the backing roll an electrode which is taken to a higher potential, whereby the web adheres under the electric forces to the roll and, simultaneously, the entry of air into the nip between the roll and the web is prevented.

The ion-blast apparatus may under some conditions act as a capacitor that accumulates an electric charge, whereby the forces adhering the web to the conducting support element become unwieldy after the web has exited from under the counterelectrode. To eliminate the effect of such adhering forces, a positive- or negative-potential corona discharge treatment can be applied downstream from the electrodes. The required corona treatment is applied using a device similar to the above-described ion-blast assembly. Instead of having a pointed tip, the electrodes may be shaped as planar or rail electrodes, and respectively, the counter-electrode need not necessarily be taken to the ground potential with the provision that its potential must obviously be lower than that of the corona-discharge-emitting electrodes or other high-potential electrodes.

What is claimed is:

1. Method for guiding of a moving web of paper or board in a paper machine or finishing equipment in which the web (6) is transported through the different process steps guided by rolls (1, 2) and support elements (7),

c h a r a c t e r i z e d by

- disposing at least two electrodes (3, 5) disposed in a close proximity to the web (6) so as to pass at least a portion of the web (6) via the gap formed between said electrodes (3, 5),

- connecting at least one of said electrodes - a counterelectrode (3) - to a low electrical potential,

- connecting at least one of said electrodes (5) to a potential higher than that of said counter-electrode (3), whereby

the electric field formed between said electrodes (3, 5) moves the web to the lower-potential electrode (3).

2. Method according to claim 1, c h a r a c t e r i z e d by

- forming said counterelectrode by a conducting support element (7) moving as an endless loop,

- Setting said conducting support element (7) to rest against at least a portion of said moving web (6), and

- disposing) in regard to said support element (7) on the opposite side of said portion of said web (6) at least one electrode (5) that is taken to a potential higher than that of said counter-electrode (3), whereby

said portion of said web (6) moving in the gap between said electrodes (3, 7) adheres to said support element (7).

3. Method according to claim 1, c h a r a c t e r i z e d in that the potential difference between said opposed electrodes (3, 5) is set so higher that it establishes a corona discharge between said electrodes capable of causing an ion blast directed toward said lower-potential electrode (3), said ion blast moving said portion of said web being in the gap between said electrodes toward said lower-potential electrode.

4. Method according to any of claims 1 - 3, in which method the tail of said web (6), advantageously at its edge, is sheared to form an edge strip (10) that is carried supported by a sequence of support means (11, 13) in a papermaking or boardmaking machine, c h a r a c t e r - i z e d in that said edge strip (10) is passed at the crossover point between two successive elements of said support means (11, 13) under the guidance of at least one stationary lower-potential electrode (3) and at least one higher-potential electrode (5) from one support element to the next successive support element.

5. Method according to any of claims 1 - 3, in which method the tail of said web (6), advantageously at its edge, is sheared to form an edge strip (10) that is carried supported by a sequence of support means (11, 13) in a papermaking or boardmaking machine, c h a r a c t e r -

i z e d in that said edge strip (10) is passed at the crossover point between two successive elements of said support means (11, 13) under the guidance of at least one moving support element (7) and at least one higher-potential electrode (5) from one support element to the next successive support element.

6. Method according to claim 1, c h a r a c t e r i z e d in that said lower potential is applied to a mandrel (17) used in winding said web (6) into a roll and the tail of said web (6) is guided to engage about said mandrel by means of electrodes adapted about said mandrel and taken to said higher potential.

7. Method according to any of claims 1 - 3, in which method the tail of said web (6), advantageously at its edge, is sheared to form an edge strip (10) that is carried supported by a sequence of support means (11, 13) in a papermaking or boardmaking machine, c h a r a c t e r - i z e d in that said support means are belt-like elements and said edge strip (10) is adhered to said support element by means an electric field.

8. Method according to claim 1, c h a r a c t e r i z e d in that the polarity of said electrodes is altered so as to alternate the local direction of the force effect caused by the created electric field.

9. Assembly for on-line guidance of a moving web of paper or board in a papermaking machine or finishing equipment in which the web (6) is transported through the different process steps supported by rolls (1, 2) and support elements (7),
c h a r a c t e r i z e d by

- at least two electrodes (3, 5) disposed in a close proximity to the web (6) so as to pass at least a portion of the web (6) via the gap formed between said electrodes (3, 5),

- means (18) for taking least one of said electrodes denoted as a counterelectrode (3) to a low electrical potential,

- means (18) for taking at least one of said electrodes (5) to a potential higher than that of said counterelectrode (3), whereby

the electric field formed between said electrodes (3, 5) moves the web (6) toward the lower-potential electrode (3).

10. Assembly according to claim 9, c h a r a c t e r - i z e d by

- having said counterelectrode formed by a conducting support element (7) moving as an endless loop,

- having said conducting support element (7) resting against at least a portion of said moving web (6), and

- having on the opposite side of said portion of said web (6) in regard to said support element (7) disposed at least one electrode (5) that is/are taken to a potential higher than that of said counterelectrode (3), whereby

said portion of said web (6) moving in the gap between said electrodes (3, 7) adheres to said support element (7).

11. Assembly according to any of claims 9 - 10, said assembly serving to guide a strip (10) that is sheared from said web (6), advantageously at its edge, and is carried supported by a sequence of support means (11, 13) in a papermaking or boardmaking machine, c h a r a c t e r - i z e d by having the guidance of said edge strip implemented with the help of having at least one stationary lower-potential electrode (3) and at least one higher-potential electrode (5) adapted to opposite sides of said strip, at the crossover point between two successive elements of said support means (11, 13).

12. Assembly according to any of claims 9 - 11, said assembly serving to guide a strip (10) that is sheared from said web (6), advantageously at its edge, and is carried supported by a sequence of support means (11, 13) in a papermaking or boardmaking machine, c h a r a c t e r - i z e d by at least one moving support element (7) and at least one higher potential electrode (5) adapted at the crossover point between two successive elements of said support means (11, 13) for passing said edge strip from one support element to the next successive support element.

13. Assembly according to claim 9, c h a r a c t e r - i z e d in that said counterelectrode is a mandrel (16) used in a winder and about said mandrel are adapted electrodes taken to a higher potential for guiding said web (6) to engage about said mandrel.

14. Assembly according to claim 9, c h a r a c t e r - i z e d in that said counterelectrodes are rolls, particularly the rolls (17) of a draw roll group and that about said rolls (17) are adapted electrodes taken to a

higher potential for adhering said web (6) to said rolls.

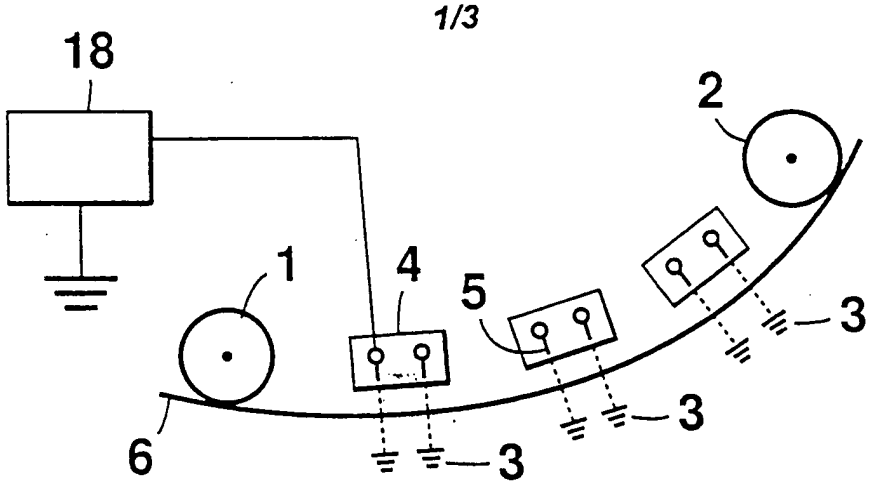

Fig. 1

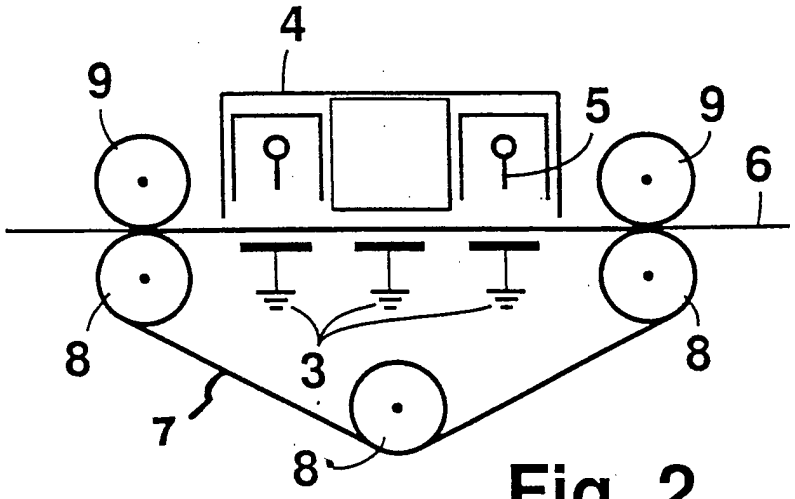

Fig. 2

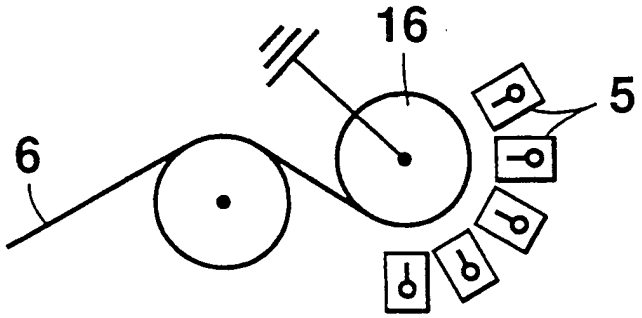

Fig. 4

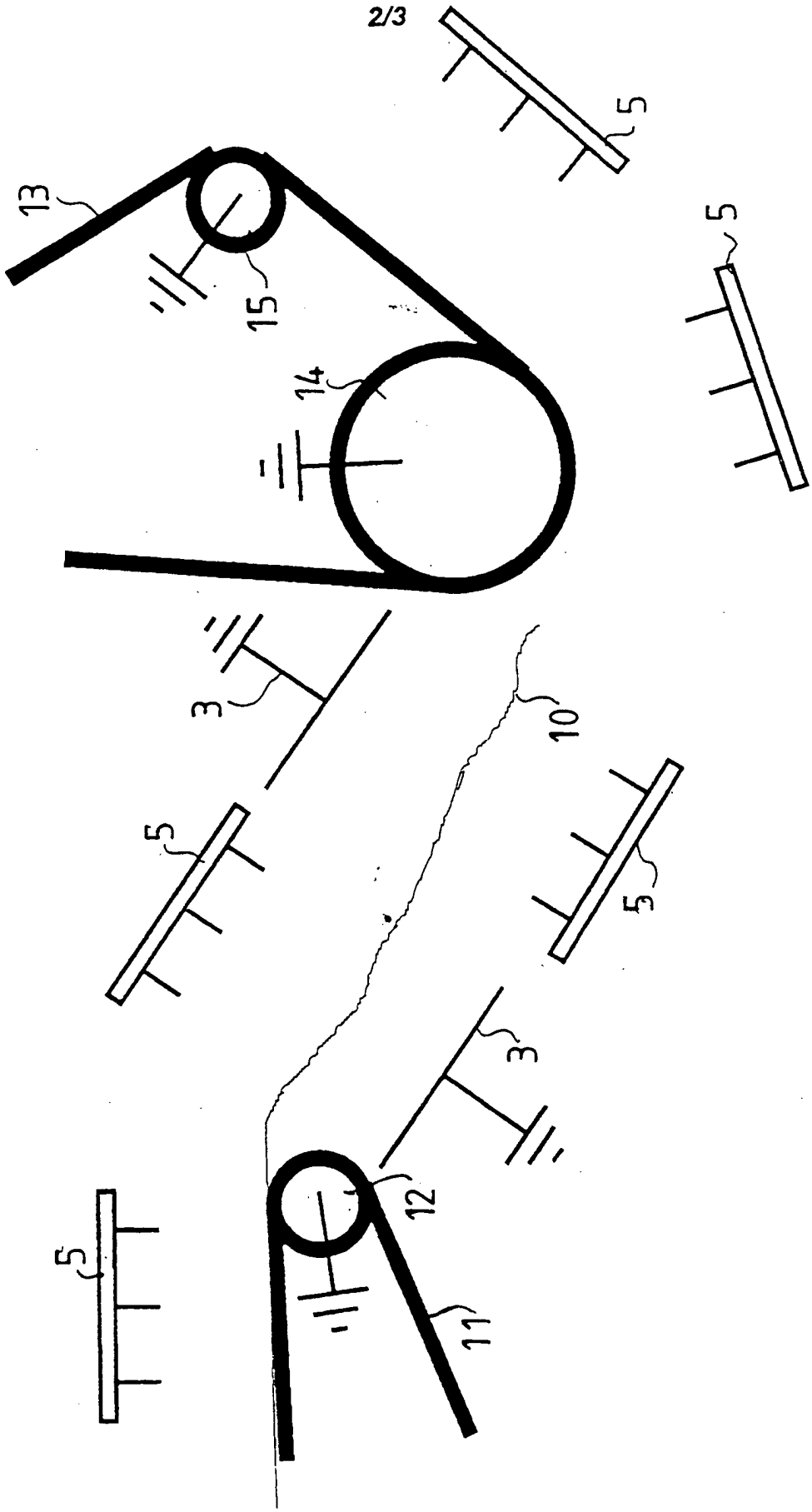

FIG 3

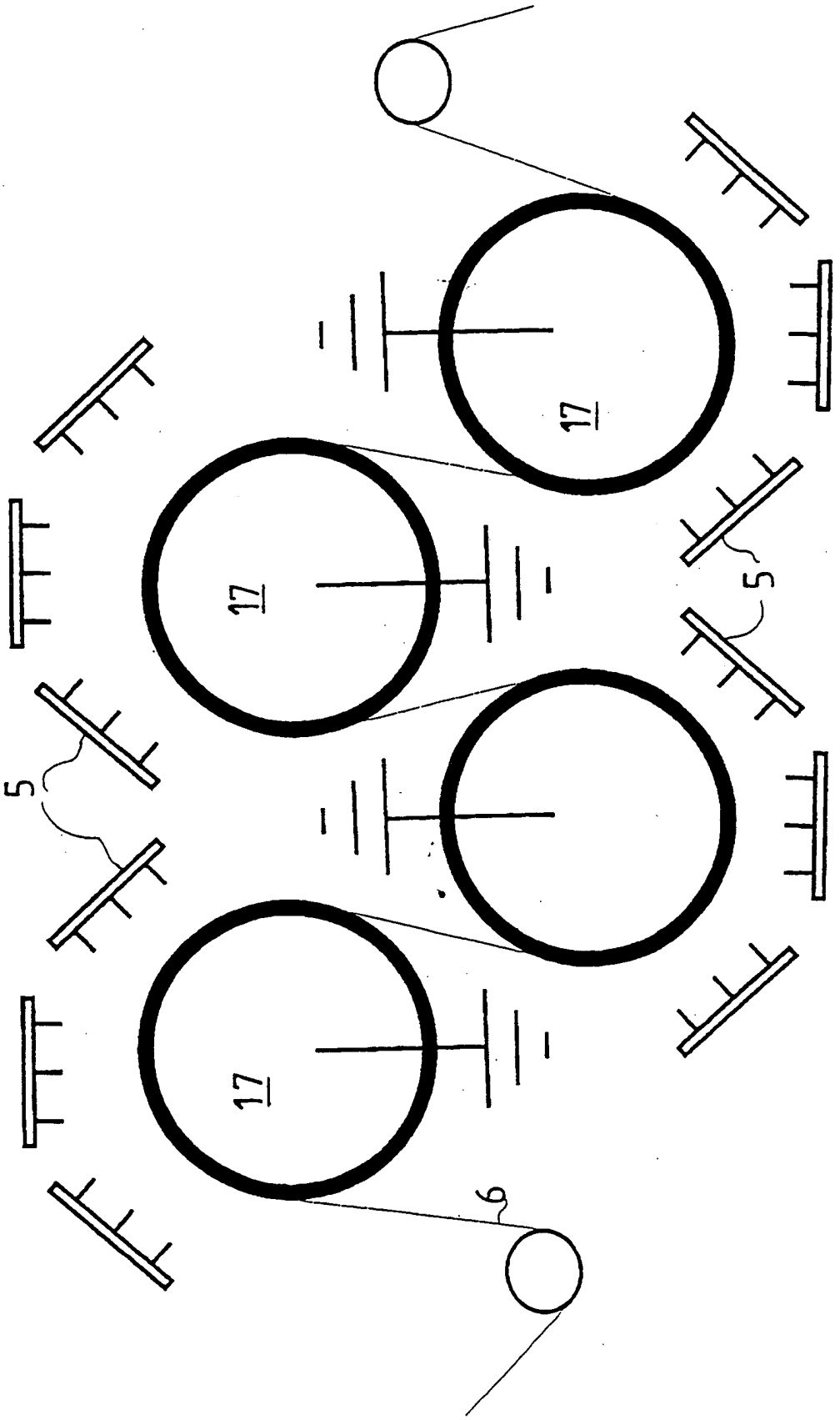

FIG 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 99/00686

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: D21F 7/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: D21F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

DIALOG: ALLSCIENCE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4257167 A (HANS-CHRISTIAN GRASSMAN), 24 March 1981 (24.03.81), column 1, line 26 - line 36; column 2, line 28 - line 58, figures 1,2a	1,9
A	--	2-8,10-14

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" erlier document but published on or after the international filing date
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"O" document referring to an oral disclosure, use, exhibition or other means
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"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 November 1999	06 -12- 1999
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Olov Jensén/MP Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

02/11/99

International application No.
PCT/FI 99/00686

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4257167 A	24/03/81	CA 1144992 A	19/04/83
		DE 2841371 B,C	14/02/80
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